

SECTION 25

PRESTRESSED CONCRETE BEAMS

1.25.1 DRAWINGS (I- BEAMS)

- (a) Details of prestressed concrete I beams are illustrated on Standard Drawing Plates 2.3-1 and 2.4-1 through 2.4-4. Mylar reproductions (594 by 841 millimeters) are available for insertion into contract plans. They may be obtained from the Engineering Documents Unit of the Bureau of Quality Management Services.
- (b) Informational notes to Designers shall be erased from the reproductions of the standard drawings prior to the insertion of the sheets into the construction plans and items marked with a (D) shall be completed by the Designer.
- (c) If continuity design for live load (see Subsection 1.25.6) is selected as a result of the bridge structure selection study, details for the positive restraint moment connection, sole and bearing plates, elastomeric bearing pads, and any other necessary details must be changed (or shown) on the standard plans.
- (d) Standard drawings for prestressed concrete voided slab and box beams are not presently available. Complete details, including the prestressed strand pattern and bearing details shall be shown in the contract plans for each bridge.

1.25.2 DESIGN CRITERIA

- (a) Design shall be in accordance with Section 3 of this Manual. Drilling for inserts into prestressed concrete beams will not be permitted.
- (b) For any pre-tensioning application, 13 millimeter diameter strands, at a spacing of 44.45 millimeters, shall be used. Also, the use of 15 millimeter diameter strands, at a spacing of 50.8 millimeters, is permitted.

Each strand shall be give an initial tension of $0.75 f_s A_s^*$ as specified in applicable sections of the PCI Design Handbook - Precast and Prestressed Concrete.

Seven-wire prestressing strands shall conform to AASHTO M 203M/M 203 (ASTM A416/A 416M), Grade 1860 and shall be low relaxation strands.

- (c) Shipping and handling stresses shall be considered when designing prestressed concrete beams. This is especially important for long span members (over 40 meters) with slender webs and small flanges.

1.25.3 ADJACENT VOIDED SLAB AND BOX BEAM DESIGN

- (a) It is recommended that adjacent slab and box beams not be utilized for bridges with skew angles greater than 30 degrees. Utilizing these beams on skews greater than 30 degrees shall be subject to approval by the Manager, Bureau of

Structural Engineering prior to the Preliminary plan approval.

Prestressed concrete box beam bridges shall utilize 1.219 meter wide box beams whenever possible. All efforts should be made to avoid a mixture of 1.219 meter and 914 millimeter wide box beams in satisfying geometrical constraints.

- (b) Prestressed concrete adjacent slab and box beams shall be surmounted with a minimum 125 millimeter thick concrete deck slab designed for composite action. Reinforcement steel shall be #16 @ 300 millimeter centers, both directions, with 65 millimeter cover (see Guide Sheet Plate 3.10-7) and shall be corrosion protected. That is, epoxy coated or galvanized reinforcement shall be used.
- (c) Non-composite design (but with composite details and construction) should also be considered. Additional reserve strength may be gained by adding several strands without a significant increase in the cost of fabricating the slab and box beams.
- (d) The Construction Specifications allow a tolerance of plus/minus 6 millimeters in the width of box beams. Abutment seats shall be detailed of sufficient length to accommodate this possible dimensional overrun in a group of beams. Abutment seats may be sloped in the transverse direction to conform with the deck cross slope, however, bearing seats shall generally be set level in the longitudinal direction parallel to the direction of the beams. If the bearing seats are not set level in this direction, gravity loads will cause shear in the elastomer. The use of a tapered sole plate or tapered grout pad may be required so that the bearing surfaces are set level to avoid imposing excessive rotation and the resulting stresses in the bearing (see Guide Sheet Plate 3.10-9).

1.25.4 TRANSVERSE TIES AND KEYWAY GROUTING

- (a) The construction plans shall be consistent with the Special Provisions. Accordingly, the following criteria shall be followed in the plan development of adjacent prestressed slab and box beam construction:
 - (1) The transverse ties shall be installed and tensioned before the longitudinal keyways are grouted.
 - (2) Keyways shall be filled with nonmetallic, nonshrink grout conforming to Subsection 914.03 of the NJDOT Standard Specifications.
 - (3) Keyways shall be grouted and cured in accordance with Subsection 502.14 of the NJDOT Standard Specifications (see Guide Sheet Plate 3.10-12).
- (b) See Guide Sheet Plates 3.10-13 and 3.10-14 for transverse tie details. Transverse ties shall be high tensile strength steel bars conforming to AASHTO M 275/M 275 (ASTM A722). Bars should preferably be 25 millimeters in diameter; however, bars up to 35 millimeters in diameter may be used, if necessary.

13 millimeter diameter, 1860 megapascal strands may also be used as transverse ties.

The end anchorage shall be protected from corrosion in accordance with Subsection 917.11 of the NJDOT Standard Specifications.

- (c) The force required per transverse tie duct per span is computed by dividing one third of the span superstructure dead load including the beams, deck, sidewalk, utilities and parapets by the number of transverse tie ducts within the fascia beam. The computed value shall be stated on an appropriate contract plan sheet.

The maximum allowable tensile stress for an AASHTO M 275M/M 275 (ASTM A722) high strength rod is based on AASHTO Article 9.15.1 and shall be assumed to equal $0.7 f_s$. The maximum allowable tensile force for a 13 millimeter diameter, 7 wire prestressing strand be assumed to equal 130 kilonewtons.

Generally rods are preferred over strands for transverse ties because the end anchorage details are less complicated. If prestressing strands are utilized as transverse ties instead of high strength rods, more than one 7 wire strand may be utilized per transverse duct, if necessary. The number of 7 wire strands required per duct is calculated by dividing the computed force per duct by 130 kilonewtons and rounding to the nearest whole number. Allowable end anchorage stresses in the prestressed beams shall be in accordance with AASHTO Article 9.15.2.4.

The total force required per transverse duct and the individual strand forces, if applicable, shall be shown on the contract plans.

- (d) Special design considerations may be required in cases where channel beams are placed next to box beams. Adequate reinforcement shall be designed in the area of the transverse ducts and/or the configuration of the shear key shall be modified such that any allowable beam sweep can be taken into consideration before the beams are tensioned.

1.25.5 BEARINGS

- (a) Subsection 1.24.19 of this Manual provides criteria for bearing systems that satisfy seismic needs. Such type bearing systems should be provided for all new prestressed concrete I Beam superstructure designs.

In the rehabilitation of existing prestressed concrete I-beam structures, that utilize steel rocker bearings, Section 45 of this Manual should be referred to for guidance in retrofitting such type bearings.

- (b) Seismic considerations shall be determined in the design of bearing systems for prestressed slab and box beam bridges. Otherwise, Elastomeric bearing pads

shall be used for prestressed concrete slab and box beams. Elastomeric bearing pads shall be designed in accordance with Section 14 of the current AASHTO Standard Specifications for Highway Bridges. The nominal hardness for laminated (reinforced) bearing pads shall be 55 " 5 durometer. For the purpose of bearing design, the bridge site shall be classified as being in temperature Zone C and the elastomer shall be Grade 3.

1.25.6 CONTINUITY DESIGN FOR LIVE LOAD

- (a) The concept of continuity design for $LL + I + DL2$ load moments shall be considered for multi-span precast prestressed concrete I-beams unless foundation conditions preclude consideration of continuous design (see Subsection 1.24.3(c)). This concept shall not be considered for bridges where the skew angle is greater than 30 degrees.
- (b) Details of the concept, which illustrate the diaphragm at the pier, continuity rebars in the deck slab, positive restraint moment connection in the bottom of the prestressed concrete I-beam, and use of preformed elastomeric bearings are illustrated on Guide Sheet Plates 3.10-15 to 3.10-18.
- (c) Design shall be in accordance with Article 9.7.2 of the AASHTO Standard Specifications For Highway Bridges.
- (d) A comparison of the concept indicates the following differences in details when compared to simple span design:

SIMPLE SPAN DESIGN for DL CONTINUOUS SPAN DESIGN for LL + I + DL2

Deck Slab:

N/A

N/A

Continuity rebars.

SIMPLE SPAN DESIGN for DL + LL + I + DL2

Deck Slab:

Preformed elastomeric compression seal or glandular type strip seal.

Steel joint armor.

N/A

Concrete placing sequence.

N/A

Deck Diaphragms at Pier:

One Diaphragm,
_____ mm wide
(depends on skew)

Deck Diaphragms at Pier:

Two Diaphragms,
225 mm wide

PC I-Beams:

Possible reduction in the
beam size-force combination.

PC I-Beams:

N/A

Possible fewer strands.

N/A

Positive restraint moment connection.

N/A

Bearings:

Refer to Subsection 1.24.19

Refer to Subsection 1.24.19

Pier Cap:

Width usually greater because of
space needed between beams for
positive restraint moment connection
and bridge skew.

Pier Cap:

N/A

Keeper block.

N/A

N/A

Corrosion protected rebars
(Epoxy coated or Galvanized)

SIMPLE SPAN DESIGN for DL
CONTINUOUS SPAN DESIGN for
LL + I + DL2

SIMPLE SPAN DESIGN for
DL + LL + I + DL2

Pier Cap:

Pier Cap:

N/A

Epoxy waterproofing seal coat.

- (e) The same size, number and arrangement of prestressed concrete beams shall be used within a series of spans made continuous for live load. Cut-off points for the continuity rebars in the cast in place deck slab shall be staggered in a minimum of three increments. A concrete deck slab placing sequence (see Subsection 1.20.6 of this Manual and Subsection 501.12 - 5 of the 1996 NJDOT Standard Specifications) shall be shown. When a two course deck slab is used, the transverse joint for the overlay shall be offset about 600 millimeters from the

joint in the first course slab.

- (f) The principal reason for the possible use of this concept is the reduction in the number of deck slab joints rather than economy. Continuity design for live load may not be practical or economical for a bridge of a few short spans, but substantial economy could result for multiple (nine or more) spans between 24 and 34 meters.
- (g) If indicated as a possible alternative for the bridge type, the continuity design for live load concept shall be used for all prestressed concrete I-beams. The simple span design concept shall be used if approved by the Manager, Bureau of Structural Engineering, prior to the Preliminary submission.
- (h) Prestressed concrete slab and box beam bridges are generally utilized on short span structures. They are usually designed as simple spans for DL+ LL+ I+ DL2 with transverse deck slab expansion joints. Transverse cracking in the deck slab overlay at the pier is more likely to occur because of the shallow deck if the continuity concept is used in the construction. Generally, the continuity design for live load concept need not be considered for the typical adjacent slab and box beam bridges, but may be considered for the occasional multi-span bridge where long span/deep box beams are required or where seismic considerations warrant.

1.25.7 EPOXY WATERPROOFING SEAL COAT LIMITS

- (a) Prestressed concrete beams shall be treated with an epoxy waterproofing seal coat conforming to Subsection 912.12 of the NJDOT Standard Specifications for Road and Bridge Construction. The limits for sealer application shall be shown on the construction plans and shall conform to the following:

<u>Beam Type</u>	<u>Areas to be Treated</u>	<u>Application limits (*), (**)</u>
I-beams	Ends, sides bottoms	1200 mm length from the beam and end for exterior surfaces and 200 mm length from the beam end for interior surfaces
Box beams, channel beams, voided slabs	Ends, bottoms and exterior face of fascia beams	1.2 meter length at the ends of beams subject to deck joint leakage

Epoxy waterproofing seal coating is not required for diaphragm connection areas.

As per bearing manufacturer's recommendations, epoxy waterproofing shall be omitted from the bearing contact area. This requirement shall be reviewed.

- * For continuous bridges epoxy waterproofing seal coat shall be applied only to the beam ends located under or near deck joints.

****** If the structure is located in a severe salt intrusion zone or a salt splash zone, (Zone 3A or 3B, see chart entitled "Zonal Areas of New Jersey Affected by Salinity" in Subsection 1.24.19 of this Manual) and is located less than 4.5 meters above the mean high salt water mark, the entire beam, along with both sides, bottom and ends shall be treated with epoxy waterproofing seal coat.